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QUERY.

Can any reader of *Science* cite a case of lightning stroke in which the dissipation of a small conductor (one sixteenth of an inch in diameter, say,) has failed to protect between two horizontal planes passing through its upper and lower ends respectively? Plenty of cases have been found which show that when the conductor is dissipated the building is not injured to the extent explained (for many of these see volumes of Philosophical Transactions at the time when lightning was attracting the attention of the Royal Society), but not an exception is yet known, although this query has been published far and wide among electricians.

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SCIENCE

NEW YORK, FEBRUARY 2, 1894.

DUST FROM THE KRAKATOA ERUPTION OF 1883.

[THE following article is a condensation of some earlier publications by Joseph Wharton, of Philadelphia, and formed a contribution by him to the papers read at the one hundred and fiftieth anniversary of the American Philosophical Society. The work of proving the origin and cause of the beautiful glowing skies that are so well remembered seems to have been assumed by this first American metallurgist as a recreation for his leisure hours. If Mr. Wharton would write of his long, laborious and successful efforts in introducing into America the manufacture of zinc and nickel and of his metallurgic work at his great Bethlehem steel furnaces, he would add a series of most valuable chapters to the history of the great industries upon which the prosperity of our country is based.—ED.]

The splendid roseate glows which in the winter of 1883-4 were visible in the western sky after sunset and in the eastern sky before sunrise gave rise to many conjectures, but apparently to almost no experiments. A few persons believed those glows to be sunlight reflected from the under surface of a stratum of fine solid particles suspended at a great height in the atmosphere; some thought with me that those particles might be volcanic dust which had floated to us from the eruption at Krakatoa, but, as no one offered any proof of this, I attempted on the morning of Jan. 20, 1884, to demonstrate it. Six miles northward from the centre of Philadelphia, where I reside, a light and fine snow was then gently falling in an almost calm atmosphere, presumably from a high altitude. Of that snow, while it was yet falling, I collected about a gallon by skimming it carefully with my hands from a considerable surface in a field a hundred yards to windward of my house and a quarter-mile from the nearest windward building.

This very clean new-fallen snow I melted under cover in the porcelain bowl it was gathered in, and was at first unable to detect any sediment; after maintaining for several minutes a gentle rotary movement of the bowl in order to bring into its deepest part any solid matter which might be present, I poured off the water and evaporated the remainder. A minute quantity of fine dust was then discerned by the tiny vitreous reflections which it gave in the sunlight; my practice in chemical analysis, and therefore in weighing small quantities, affords some justification for the estimate that the total weight of this dust was less than one-hundredth of a grain.

Under the microscope, where it was immediately placed, this dust showed the characteristics of volcanic glass; it consisted in part of irregular, flattish, blobby fragments, mostly transparent and showing no trace of crystalline structure, in part of transparent filaments more or less contorted, sometimes attached together in wisps and mostly sprinkled with minute glass particles. The filaments of glass had about the same diameter as single filaments of silk placed on the microscope slide for comparison with them.

Having microscopically examined the dust again and again, I ignited it upon platinum to destroy any organic matter which might be present, and thereafter found the filaments, the flat plates, and the amorphous accretions of glass quite unchanged.

No pyroxene, augite, or magnetite, such as have elsewhere been observed in volcanic dust, was present; it may be assumed that, if at first mingled with the glass, those heavier minerals had been dropped during the long voyage of more than ten thousand miles of space and more than four months of time.

The capacity of fine volcanic glass to float in the air to considerable distances being a well-established phenomenon, my examination claims no greater novelty or interest than what may be due to the actual finding of such glass at so great distance from the point of its ejection.

In this case two separate ejections seem to be indicated, for on several evenings I observed a second and fainter glow after the original and stronger glow had entirely disappeared. A higher stratum of finer particles doubtless reflected the sunlight from the greater altitude after the sun had set at the lower elevation of the principal dust stratum.

Early in February, 1884, the ship J. E. Ridgeway arrived at Philadelphia from Manila by the Strait of Sunda. On Feb. 12 I visited that ship, and read on her log-book that at 10 p.m., Oct. 27, 1883, in south latitude 7° 57′ and east longitude 100° 54′ (about five hundred miles W.S.W. from Krakatoa), she encountered a vast field of floating pumice, through which she sailed until 7 a.m., Oct. 29. So abundant was this pumice that the ship's speed was reduced from nine knots when she entered it to two knots at 6 p.m., Oct. 28; several hours after that time her speed gradually increased, as the pumice became less dense, from two knots to eight, and finally, when she cleared it, to her normal nine knots. No volcanic ash had fallen upon the ship, as she arrived too late upon the scene.

Some of this pumice I took directly from the hands of the mate and steward, who had collected it from the sea and had kept it in their private lockers. It can scarcely be doubted that this pumice was ejected from Krakatoa.

Now, on placing under the microscope small crumbs of that pumice and filaments picked out from its cavities, I recognized just such transparent flattish scraps and ragged accretions as were among the dust found in the snow-fall of Jan. 20, while the filaments, though less varied and interesting than those then collected, where quite similar in character, even to the tiny glass particles sprinkled on them. A minor point of resemblence was that the yellow color of one little vesicular mass in the dust caught Jan. 20 was fairly matched by a slight streak of similar color in the pumice.

In March, 1884, I collected dust from the steel works at South Bethlehem, Pa., and also dust from a blast furnace there, in order to compare them with the dust

found in the snow and with the filaments and crumbs of pumice from the ship J. E. Ridgeway.

After separating from these dusts the large proportion which was attracted by the magnet, the remnant showed in each case many vitreous particles ; that from the iron furnace largely spheroidal or globular, with a few filaments ; that from the steel works partly minute rounded particles, but containing many filaments of great tenuity. Neither contained such clear vitreous plates and aggregations as abounded in the snow-dust, while the filaments in both cases were of dark color, and smooth, straight form, distinctly different from the colorless and frequently contorted filaments of the snow-dust.

It is difficult to resist the conclusions (1) that the vitreous dust found in the snow-fall of Jan. 20, 1884, was not derived from iron or steel furnaces, (2) that it was of similar origin to the floating pumice found by the ship J. E. Ridgeway, (3) that it was ejected by the huge volcanic explosions of Krakatoa.

To meet the objection which might be urged, that this account cannot be regarded as accurate because written so long after the occurrences, I add that it is simply condensed from three successive articles contributed at the time to the *Public Ledger*, of Philadelphia, describing respectively the finding of the vitreous dust in the snow-fall, the examination of pumice from the ship Ridgeway, and the scrutiny of furnace dusts.

FAMILIARITY OF CERTAIN WOOD BIRDS.

BY MARY HYATT, STANFORDVILLE, N. Y.

SOME of our wood birds depart occasionally from the prescribed course laid down for them by ornithologists, and come to our orchards and lawns, instead of haunting deepest woods and distant solitudes, as the authorities say they should.

A certain lawn surrounding a dwelling in Dutchess County is often favored with the presence of various wood birds—not transient visitors only, but birds that make themselves thoroughly at home in the garden and yard, sometimes building nests quite near the house. Beyond the garden there is a ledge of rocks, around and over which bushes and trees are allowed to grow, forming an attractive spot to these fugitives from the forest.

One summer a pair of wood pewees (*Contopus virens*) nested in a towering honey locust that stood five feet from the piazza. The trunk of the tree was crusted with gray lichens, with which the pewee coats the outside of its nest, the inside being usually composed of scraps of wool and inner fibres of decaying bark. The domicile of these sociable pewees was saddled upon a horizontal limb of the honey locust about thirty feet from the ground. By looking from the top-floor windows, one could just see the heads of the young projecting from the top of the nest. Now and then a parent bird appeared with a moth or some such delicacy for the little ones. The old birds spent much time on a wire fence between the garden and meadow. From there they made frequent dashes after insects, returning to their wire perch, where they remained for hours each day, quietly indifferent to all passers. The pewees seemed to have great confidence in their human neighbors. One day, as an occupant of the dwelling was walking leisurely along near the fence, one of the pewees darted down and snatched a little insect from the shoe of the passer, then flew serenely back to the wire again.

The redstart is another frequenter of this yard and orchard. Its nest has not been found, but it is more than probable that it has nested somewhere about the yard, which is well supplied with trees and shrubbery. The redstarts have been seen feeding young birds near the door, but they dart about so swiftly that it is no easy matter to find their nesting places. They often came about the door, sometimes hopping tamely on the ground, and once a redstart flew in the open doorway, picking up a crumb from the floor and departing as suddenly as he came.

A pair of wood thrushes started house-keeping one summer in a plum-tree by the driveway. The nest was built, and the eggs were laid when Madam Thrush met with untimely death. She was found gasping on the door-stone one morning, and in a few moments the bird was dead. It was supposed that she had dashed against a window, thinking to fly through. The mate of the dead bird lingered a couple of days in the vicinity of the nest, and then departed from the premises, returning no more to his favorite lawn, where he had explored the flower-beds for many a day, sometimes singing on the very door-stones.

The crested flycatcher (*Myiarchus crinitus*) occasionally makes himself quite prominent about the grounds. One year there were several of these saucy fellows calling so constantly and noisily through the yard for two or three weeks in May that they attracted much attention.

The oven bird is one who delights in parading the flower-beds or walking the garden wall when he thinks no one is looking. Upon one occasion we caught him promenading the piazza, walking briskly up and down until his curiosity was satisfied, when he darted away, sounding a lively crescendo from behind the trees.

—The latest number of the *American Journal of Psychology* (edited by G. Stanley Hall, Clark University, Worcester, Mass.) opens with an extensive article (pp. 145–238) by T. L. Bolton, on "Rhythm," in which the author discusses interestingly the almost untouched field of the psychology of rhythmic phenomena,—treating of physiological rhythms, attention and periodicity, rhythmic speech, time relations, intensity of sounds, qualities of sounds, emotional effects of rhythm upon savages and children, rhythmic, music and poetry. The main bulk of Mr. Bolton's paper is taken up, however, with the tabulation and explanation of the results of many valuable experiments on rhythm carried out in the Psychological Laboratory of Clark University. "Minor Studies from the Psychological Laboratory of Cornell University," "Mediate Association," by H. E. Howe, and "Sensorial and Muscular Reactions," by A. R. Hill and R. Watanabe, are communicated by Prof. E. B. Titchener. Mr. Howe's experiments seem to controvert Scripture's "Mediate Association." Mr. J. A. Bergström contributes a careful "Experimental Study of Some of the Conditions of Mental Activity." The experimental work upon which the paper is based was done in the laboratory of Clark University in the last two years. The questions treated of are chiefly "Natural Rhythm of Mental Activity" and physiological memory. Mr. F. B. Dresslar publishes "A New Illusion for Touch, and an Explanation for the Illusion Displacement of Certain Cross Lines in Vision," besides a "New and Simple Method for Comparing the Perception of Rate of Movements in the Direct and Indirect Field of Vision," two interesting additions to the stock of laboratory experiments. Mr. J. S. Lemon has a brief paper on the "Psychical Effects of the Weather," a subject with which he promises to deal more in detail on a future occasion. The number concludes with the usual extensive review of the literature of anthropological psychology, nemology, morbid psychology, instinct and experimental psychology.

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THE RELATION OF THE SOUNDS OF FOG SIGNALS TO OTHER SOUNDS.

BY CHARLES A. WHITE, SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

IT is now generally known that within the range of possible audibility of most, if not all, the fog signals which the various civilized governments have established along their coasts, each usually in connection with a lighthouse, there are certain areas within which the sound of these signals are inaudible. It is also known that areas of more or less complete inaudibility of sounds, when projected from certain directions, sometimes occur upon the land; but only those which occur upon the water will be specially referred to in this article, and they will be discussed only with reference to their relation to stationary fog signals. Such acoustic conditions being a constant menace to navigation during a fog, the various governments concerned have instituted inquiry into the character and limitations of those areas and, incidentally, into their causes. Our own government has been, and still is, active in experimental studies of this kind, but the records do not show that any of those studies have been more than incidentally directed to that particular phase of the subject which is indicated by the title of this article.

The areas of inaudibility referred to are of two kinds, each area of both kinds bearing a similar special relation to a neighboring fog signal. One of these kinds is made such in every case by a true acoustic shadow of a stationary visible object, usually a small elevated island, or a ridge of land running out into the water, at, or near, one side of which the fog signal is located. That is, such an area is simply one which an essentially permanent acoustic shadow occupies.

The areas of inaudibility of the other kind occur in broad open waters. There is never any visible indication of their presence, and in connection with, or near, none of them is there any visible object above the water surface, and therefore nothing which could cast a true acoustic shadow there. Whatever may be the cause or causes of inaudibility of the sounds of the neighboring fog signal in areas of this kind, it is evident that at least a considerable part of the acoustic conditions prevailing in them are in effect identical with conditions which characterize the other kind. That is, certain of the effects produced within these areas are the same as those which are produced by a true acoustic shadow in each of the first mentioned kind of areas.

It is impracticable to discuss these areas and to compare each kind with the other without applying to each kind a distinctive name. I have therefore selected for the first mentioned kind the name montumbral, and for the second, the name pseudumbral, areas. The first name is selected because the areas to which it is applied are in every case made such by the acoustic shadow of a hill or ridge. The second name is selected because the acoustic conditions which prevail in the kind of areas to which it is applied are, as has just been mentioned, largely identical with those which are produced in the other kind by true acoustic shadows.

The elevated island or ridge which lies between a fog signal and a montumbral area casts an acoustic shadow over the latter just as at night it casts an optic shadow over the same area by intercepting the light from the lighthouse with which the fog signal is connected. The bounderies of a montumbral area are therefore determined by the profile outline of the elevated island or ridge which causes it, but they are modified and restricted, as compared with those of an optic shadow, by the great lateral diffusion of the sound waves, and by their tendency to soon coalesce beyond any object which may separate or obstruct them. That is, the lateral boundaries of an optic shadow diverge beyond the intercepting object, while those of an acoustic shadow have a strong tendency to converge there. The diagram which follows further on approximately illustrates the character of a montumbal area besides other conditions which sometimes may be connected with it, as will presently be explained.

It will thus been seen that what I designate as montumbral areas are in each case identical in outline with an acoustic shadow which is necessarily permanent, or only slightly varying as to its boundaries with changes of atmospheric conditions. Beyond this, montumbral areas, unlike pseudumbral areas, as will presently be shown, are not potentially variable. Acoustic shadows occur under a great variety of conditions, but montumbral areas as I have defined them are not numerous.

Excepting the absence of the direct sounds of the fog signal within a montumbral area the acoustic conditions prevailing there are normally the same as are those which prevail on all the water surface adjacent to it. That is, in case no other acoustic shadows are cast there by other objects, intercepting other neighboring sounds, it is an area of inaudibility only of the sounds of the neighboring fog signal and of such other sounds as may be projected from points within a limited distance upon either side of the fog signal. This inaudibility is caused by a complete interception or destructive arrest, by the adjacent elevated island or ridge, of a portion of the sounds which the fog signal projects towards it. All other sounds of whatsoever kind, if sufficiently intense for such distances, may, with the following exceptions, be projected from, into, or across the area in any direction.

The exceptions are that, because the elevated island or ridge intervenes, sounds connot be projected to points adjacent to its other side from points within the montumbral area, and of course such sounds cannot reach the place of origin of the neighboring fog signal's sounds. Also, the projection of other sounds than those of the neighboring fog signal into the montumbral area from points at such distances at either side of the fog signal as accord with the length of the elevated island or ridge, will be more or less completely prevented by the presence of the latter, just as it prevents the projection of the fog signal's sounds into that area.

Pseudumbral areas are of more frequent occurrence than are montumbral areas, and in various ways they are more important. Still, their discovery is always empirical because there is never any visible indication of their ex-

istence; and when one is discovered its shape and extent can be known only by special investigation. It is known, however, that the shape and extent of pseudumbral areas are very variable, and also that their location is uncertain as regards distance and direction from the fog signals whose sounds are inaudible within them. They are also very variable in outline, and the distinctness of the boundary of each is usually, if not always, variable in its different parts. That is, if the area may be propery designated as umbral, the term penumbral may not inappropriately be used to indicate the indefiniteness of certain portions of the boundaries of those areas.

Furthermore, certain known facts indicate that all the conditions which characterize a pseudumbral area at one time may be absent from nearly or quite the whole area at another time. These areas, therefore, unlike montumbral areas, are always potentially, and apparently always actually, variable, not only in outline but in position and duration. Still, they frequently have sufficient permanence for systematic study; and Major W. R. Livermore, Engineer in Charge of the First and Second United States Light House Districts, has successfully mapped some of them.

Experimental study of pseudumbral areas is necessarily made on board of vessels, and as the observer directs his course away from the fog signal, which is meanwhile kept regularly sounding, he becomes aware of having reached the proximal boundary of a pseudumbral area by the gradual, or often sudden, failure of the fog signal's sounds to reach him. Continuing in that direction, if open water be there, he comes to the distal boundary of the area when the fog signal's sounds are again heard, usually with little diminution of their intensity. The biological terms, proximal and distal, are borrowed and applied to the nearer and opposite sides, respectively, of the area, with reference to the location of the fog signal.

Although, as has already been mentioned, a considerable part of the acoustic conditions which prevail in a pseudumbral area are, in effect, identical with conditions which characterize montumbral areas, two important differences between the conditions prevailing in the two areas respectively are known, besides the difference as to permanency just mentioned. First, in the case of a pseudumbral area there is no such interception or destructive arrest of any portion of the fog signal's sounds by a visible physical object as takes place in the case of a montumbral area. The inaudibility is caused by some invisible physical force or condition, but how that force acts, or what that condition really is, has long been the subject of wide differences of opinion and of earnest controversy. Second, independent sounds *can* be projected from points within a pseudumbral area to the place of origin of the neighboring fog signal's sounds, further mention of which fact will presently be made.

The cases discussed under the head of Acoustic Reversibility by Professor Tyndall,[1] and some of those related by Professor Henry[2] concerning his experiments while he was Chairman of the United States Light House Board, agree with the foregoing statements, one of the latter cases being especially important in this connection.

Many of Professor Henry's experiments were made to ascertain the relation to one another of sounds responsively produced, such, for example, as those which he made with the whistles of steamers off Sandy Hook in 1874. He showed that sounds may be returned from an area in which similar reciprocal sounds, projected from other points, are inaudible, and he urged this fact against Professor Tyndall's theory that the cause of such inaudibility is a flocculent condition of the atmosphere. The experiment which I wish particularly to refer to, however, was made with reference to the sounds of a stationary fog signal, and it is therefore of special interest to the subject of this article. The result of this experiment was the projection from within a pseudumbral area of the sounds of the whistle of the steamer upon which he was making his observations to the immediate vicinity of the neighboring fog signal. While the steamer was moving away from the fog signal, which was meanwhile kept regularly sounding, the steamer entered an area where the sounds of the fog signal became inaudible. The steamer's whistle being then blown, its sounds were distinctly heard by observers standing beside the fog signal.

Professor Henry died soon after the last of the experiments referred to were made, and they have not, to my knowledge, been continued. However, considering the facts which he then demonstrated, together with other facts concerning the acoustic conditions which are known to prevail in both pseudumbral and montumbral areas, I cannot doubt that sounds of any kind, if sufficiently intense for such distances, may be projected into or across pseudumbral areas as readily, and in the same manner, as into or across montumbral areas. That is, I think the facts now known warrant the opinion that a pseudumbral area is one of inaudibility only of sounds coming toward that side of it which faces the neighboring fog signal.

The question may be raised whether the acoustic conditions which usually prevail in connection with pseudumbral areas may not sometimes be complicated by the simultaneous presence of such an additional force or condition as would make them areas of inaudibility of certain other sounds besides those of their neighboring fog signals. I am not aware of any fact which favors the supposition that such complications ever exist, nor do I now think they are to be expected. This statement, however, has no reference to the assumed inaudibility within the pseudumbral area of sounds which may be projected from points within a short distance upon either side of the fog signal, because it is evident that, to a greater or less extent, such sounds are controlled by the same cause which controls the fog signal's sounds. The question may also be raised whether the condition which produces inaudibility of the fog signal's sounds, without reference to other sounds, may not also be complex. I am not, however, at present prepared to discuss the question of causes of inaudibility of sounds in pseudumbral areas. Still, I think that exhaustive investigations concerning the relation of the sounds of fog signals to other sounds, in connection with pseudumbral areas, are likely to throw much light upon it.

In view of the variability of those areas it is evidently desirable that various experiments showing such relation should be simultaneously made when one of them is discovered. For example, it is desirable that several vessels, each provided with the means of producing various penetrating sounds, should surround and traverse the pseudumbral area and attempt the projection of those sounds into, from, and across it in all directions; the neighboring fog signal being meanwhile kept regularly sounding. As a matter of course all such experiments should be accompanied by observations of all atmospheric conditions, especially those which affect, or which are supposed to affect, the propagation of sounds.

Such experiments would tend to show, among other things, what becomes of the sounds of a fog signal upon reaching the proximal boundary of a pseudumbral area. For example, if it should be ascertained that such sounds as I have indicated may be projected in various directions through the very space in which a fog signal's sounds are at the same time inaudible, it would demonstrate what I

[1] Tyndall, John; Sound, 3rd edition, p. 403.
[2] Henry, Joseph; Researches in Sound, pp. 493, 501, 503, 510 and 547.

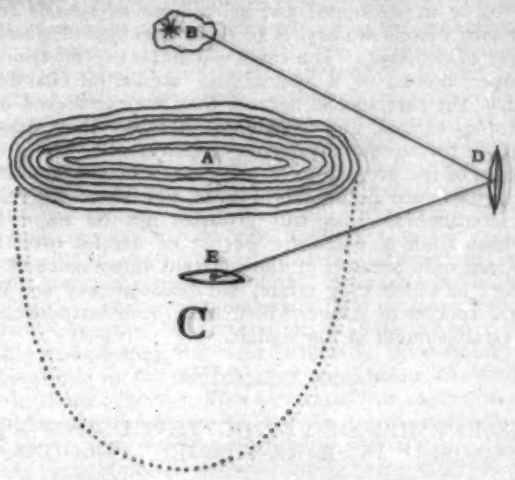
have suggested, that such inaudibility is mainly, if not wholly, dependent upon causes acting in only one direction. If then it should be ascertained that independent sounds may be projected from a point just within the proximal boundary of a pseudumbral area to a point beyond its distal boundary, it would of itself be a demonstration that the fog signal's sounds become either refracted or annulled at the proximal boundary of the area.

The frequent, if not the usual, recovery of the fog signal's sounds in strong intensity beyond the distal boundary of a pseudumbral area seems to show that there has been no permanent annulment of those sounds either at the proximal boundary or elsewhere. It also seems to indicate that their restoration is at most only in part due to such diffusion and coalescence of sound waves of the fog signal as quickly restricts the extent of a montumbral area, and makes those sounds audible beyond its distal boundary. It therefore becomes desirable to investigate the air above pseudumbral areas with a view to learning whether the fog signal's sounds pass there uninterruptedly to the distal side of the area. The investigations by balloon which have been proposed by both Mr. Johnson and Major Livermore will evidently be the means of testing this question, and they will doubtless aid in other ways to increase our knowledge of the acoustic conditions which prevail in pseudumbral areas.[3]

The preceding paragraphs are largely suggestive of scientific results yet to be attained. The facts now to be mentioned are suggestive of dangers to navigation to be avoided or guarded against. Last autumn, while a member of the party of investigation whose operations were described by Mr. A. B. Johnson in *Science* for January 5th of the present year, I made some observations of echoes of the sounds of fog signals which are of special interest in this connection. The most important of these observations were made upon Great Gull Island, at the eastern end of Long Island Sound, and the echoes were those of the fog signal, a siren, which is connected with the lighthouse on Little Gull Island, about half a mile from my point of observation. There was no fog at the time these observations were made, but the siren's sounds were given regularly that their variations of audibility might be studied in the surrounding region.

The echoes were received from the sails of several schooners which were standing in the offing with all sails set and close hauled by the wind. The vessels varied in distance from me and from the siren from half a mile to nearly two miles. The wind was light, there was perfect silence around me, and the echoes reached me with almost startling distinctness. In timbre, or quality, they were exact reproductions of the siren's sounds; and in duration and time-interval they also agreed with them. I estimated the intensity of the echoes at from 1 to 3 in a scale of 10, the latter number representing the full intensity of the siren's sounds. The angles of incidence and reflection by which they reached me were from 20, to somewhat more than 40 degrees.

Considering the intensity and distinctness of those echoes, their identity of timbre, time-length and time interval with those of the direct sounds of the siren, the distances from which they were reflected, and the broad angles of incidence and reflection by which they reached me, I was impressed with the belief that such echoes, when heard within either pseudumbral or montumbral areas, may be a source of danger to passing vessels. The following diagram will show how sail-echoes of a fog signal may be a source of danger to a vessel traversing a montumbral area in a fog, and it also illustrates the character of montumbral areas as they have already been described.



A, represents an elevated island; *B*, a small island with lighthouse and fog signal, and *C*, a montumbral area, the seat of an acoustic shadow caused by the elevated island. *D*, represents a schooner with all sails set and close hauled. *E*, represents another vessel, within the montumbral area, where of course the direct sounds of the fog signal are inaudible. Those sounds, however, reach the sails of the vessel at *D*, and are reflected to the vessel at *E*, as an echo. To persons on board the vessel at *E*, the sounds of the fog signal seem to come from the direction of *D*.

Sail-echoes of a fog signal which are recovered beyond the distal boundary of a montumbral area may, perhaps, also be reflected back into it, but lateral reflections, such as are represented by the diagram, are probably more likely to occur.

It cannot be denied that the permanent conditions necessary for the casting of an acoustic shadow of a fog signal's sounds across a navigable channel, or a usual track of vessels, are not common, but such conditions do exist in connection with certain of the fog signals which have been established along our coasts. Neither can it be denied that the occurrence of such a combination of permanent and adventitious conditions for reflecting the sounds of a fog signal from the sails of vessels into a montumbral area as is represented by the foregoing diagram is likely to be rare. Still, there is an undeniable probability that such cases may occur at any time, and it is also undeniable that they may be attended with danger whenever they do occur.

If my assumption is correct that a pseudumbral area is one of inaudibility of only such sounds as are projected towards that side of it which faces the neighboring fog signal it may legitimately be assumed that sail-echoes of the fog signal's sounds may be projected into such an area just as they may be projected into a montumbral area. That is, if a pseudumbral area should be a short one, sail-echoes of the neighboring fog signal may be projected into it laterally in the same manner that they are represented by the foregoing diagram as being projected into a montumbral area. Recovered sounds of the fog signal, upon the distal side of the pseudumbral area, may also be echoed back into that area from the sails of vessels. Such echoes may enter a pseudumbral area from any point of the compass within a range of, perhaps, one half the horizon. To persons on board a vessel traversing one of these areas during a fog those echoes might readily be mistaken for the direct sounds of the fog signal, and the true location of the latter would in every case be falsely indicated.

The conditions under which echoes occur are numberless, and their observation has from time immemorial been prominent among the practical duties of mariners. They habitually use echoes of permanent objects as aids,

[3] Since the foregoing paragraphs were written Major Livermore has informed me that in experiments lately performed under his direction the sounds of a bell and of a steamer's whistle were projected both into and out of pseudumbral areas, thus demonstrating in large part what I have suggested.

and as warnings from danger, when guiding their vessels in a fog or in darkness; and sail-echoes of sounds from their own vessels are always to them warnings of possible danger of collision. The cases which I have mentioned, however, are all of a special and accidental character. That is, they are special because they are connected only with fog signals, and accidental because they depend upon the fortuitous movements of sail vessels.

Cases of the projection of sail-echoes of the sounds of fog signals into pseudumbral areas, like those suggested for montumbral areas, will probably not be numerous, but both kinds of cases are worthy of careful investigation, not only because of the inherent importance of the subject to which they relate, but because they are incidental sources of danger which have been introduced by the establishment of fog signals.

THE ENEMIES OF LEPIDOPTEROUS PUPÆ ENCLOSED IN BARK-FORMED COCOONS.

BY EDWARD B. POULTON, M.A., F.R.S., HOPE PROFESSOR OF ZOÖLOGY IN THE UNIVERSITY OF OXFORD, ENGLAND.

THE beautiful and perfect concealment of the cocoons constructed out of bark by many species of Lepidoptera has often attracted attention and admiration. In some species, such as the British *Acronycta leporina*, the larva tunnels deeply into the bark, constructing a chamber at some distance beneath the surface, and carefully removing the bark-dust formed by its building operations. The mouth of the tunnel is closed by fragments of bark spun together so as to form a covering exactly flush with the surrounding surface, which it also resembles in texture and color. In other species a natural crack or furrow in the bark is selected by the larva and is similarly covered in level with the bark around. In the genus *Cerura* (*Dicranura*) the larvæ excavate an oval area which is covered in by a more or less domed roof, similarly built of pieces of bark so well fitted and woven together that the appearance is exactly that of some rounded, flattened or irregular projection on the trunk of the tree. Furthermore, in the choice of situation it is usually found that increased aid to concealment is afforded; the apparent projection being formed on an appropriate part of the trunk, and with due regard to the existence, arrangement and direction of the irregularities of its surface, such as furrows, etc. Those who believe in the efficiency of Natural Selection in evolution will probably regard this interesting method of concealment as the outcome of countless generations during which the attacks of enemies have been, on the whole, more successful against the products of less perfected instincts, and less so against those of the more perfected. Furthermore, we must suppose that the increasing perfection in instincts has acted selectively on enemies, sharpening their faculties, until, by action and reaction, the present high level of constructive skill has been reached, and is maintained.

How far is it possible to gain evidence of such a relationship between enemies and prey? At first sight, one of the cocoons I have described appears to be so perfectly concealed as to defy the sharpness of any enemy, however acute. But observation, especially directed to this end, will show that such an inference is incorrect.

On April 12 of the present year I was examining the bark of a black poplar (*Populus nigra*) near Yoxford, in Suffolk, and found a cocoon of the "Poplar Kitten" (*Cerura bifida*) which had evidently been recently opened by some enemy, almost certainly a bird, and the chrysalis extracted. The edges of the opening were still brown and fresh, as was the interior of the cocoon; and the larval skin remained fresh and untouched inside. The opening was in the middle of the exposed surface and not at one end, as it is when the moth emerges. Besides, the cocoon had been opened and cracked by a blow from some hard object such as a bird's beak, and the sharp irregular margins were quite different from those of the natural opening made by the moth, doubtless by means of a corrosive fluid, as in the allied species, *Cerura Vinula*, which Mr. I. H. Latter has recently shown to secrete caustic potash for this purpose. Furthermore, the moth emerges far later in the year, and, had it emerged at an exceptional time, the empty pupal skin would have been left behind in the cocoon. We may therefore safely assume that the opening was the work of an enemy, and, as the cocoon was five feet from the ground, it was probably due to some tree-creeping, bark-exploring species of bird.

After the hint supplied by this observation I found that such instances are quite common and that a considerable proportion of these cocoons are thus opened and their contents abstracted. It is probable that the attention of the enemy is directed to any cocoon-like object by the sense of sight and that the object is then tapped, and, if found to be hollow, opened and the pupa devoured. If I am right in supposing that the pupa has to run the gauntlet of such dangers as these, it follows that any carelessness in construction or in the selection of a site would tend to be eliminated, and we are able to picture to ourselves, with a considerable degree of probability, the kind of conditions under which this wonderful form of protective concealment has been developed and is now maintained.

These conclusions are perhaps capable of being brought to a crucial test, and, as this involves much time and much observation, it is to be hoped that several naturalists may attack the question. During the winter and spring a large number of such examples should be collected and noted, with special reference to the degree of concealment exibited by the opened cocoons as compared with those which are found to have escaped attack. The subjective element would require to be checked by calling in the aid of others who are ignorant of the point under consideration but possess the requisite accuracy of eye. Attention should only be paid to fresh cocoons which have been opened in the season of the observation; for the old battered cocoons of past seasons will be commonly found on the trunks. It may be that the problem demands too large a number of examples to be capable of solution in this way; but on the other hand it is possible that positive evidence may be forthcoming.

AN OBSERVATION ON THE TERMINAL VERB IN INFANT SPEECH.

BY E. W. SCRIPTURE, NEW HAVEN, CONN.

IT has sometimes been asserted that the most natural position for the verb is not at the end of the sentence, and that children would not of themselves separate the participle or infinitive from the auxiliary or main verb, as is done in German syntax. I wish to record a personal observation to the contrary.

The child, W.S., twenty-nine months old, has not learned any language but English, and has not heard any sentences constructed otherwise than according to correct grammatical rules. W. S. was told to ask for some money to buy shoes, but in doing so said, "I want some money for my shoes to buy." Upon the question "What?" the sentence was repeated without change. On other occasions W. S. uses the words in the customary order, *e. g.*, "I'm going buy new shoes." The observation seems to prove that the terminal position of the infinitive is at least not unnatural.

THE COLUMBIAN AND THE CENTENNIAL EXPOSITIONS.

Now that the world's fair at Chicago is over, the last half dollar taken from the public and the splendid buildings which have not been entirely removed either dismantled or burned, it can do no harm to compare the two world's expositions in the United States.

The first was born of a great patriotic uprising of the people—chiefly of Philadelphia—to commemorate the birth of the nation. The second was the fourth centennial of the discovery of this continent, for which enthusiasm was manufactured by means of the powerful aid of the Government, added to hitherto unheard of subsidies of money, and by means of unprecedented advertising at enormous expense undertaken by reason of the ambition of a great young city of which the motto is "I will." It is not too much to say that the Government of the United States did not expend a dollar without return for the elder exposition, while it freely gave millions for the later one.

Charles Sumner in the Senate and Mr. Springer of Illinois in the House of Representatives opposed the giving of Government support to the former, while all the representative members of every state's delegation to Congress, and notably those of Pennsylvania, united to further the objects of the later project. Had it not been for the munificence of private monied men of Philadelphia, and the contribution of small sums by her less fortunate people, the Centennial would needs have been abandoned. Yet the donations of foreign countries and exhibitors to the Government scientific museums in Washington were, in proportion to their magnitude (and perhaps actually) greater in the first exposition than in the last.

A recent communication to the public press by an observant student of the late Exposition in Chicago contains the following language:

After stating that Philadelphians must admit "the far greater richness and elaboration" of the later enterprise, it proceeds to state that the Chicago Fair "cost three times the money of the Centennial, and while it has about the same greater proportion of exhibits, it has by no means a three-fold power on national invention and progress." . . . . "It is doubtful indeed if all these added millions add an ounce to the momentum exerted by the Centennial, and for the reason that everything here beyond the essentials of practice, which were demonstrated at the Centennial, are in the simple though immense direction of spectacle, constituting a bewildering appeal to the senses but not being of necessity a lasting force in industrial science."

The writer of these lines may claim both the desire and the opportunity to make a fair comparison between the two expositions in the department of mines and mining, having occupied positions in both expositions which gave him facilities for doing so.

He can only bring to the judgment of the other exhibits such qualifications as any man of ordinary intelligence and the experience of several world's fairs possesses.

The buildings; their arrangement with reference to each other and to the general architectural effect; the laying out of the grounds and all those many elements of architectural taste which are so difficult to catalogue, were never so perfectly attained in any part of the world as they were in Chicago. The buildings themselves, too, were spacious, well fitted for their purpose and imposing in their lines.

In all the above respects, and perhaps in the means of transportation of crowds to and from the grounds, the Chicago Fair was in advance of any enterprise of the kind ever undertaken.

But the appearance of the interiors was not in keeping with the majesty of the structures. Even to the superficial glance the exhibits seemed too often commonplace or "padded." Not but what there were thousands of gems imbedded in this matrix of mediocrity and advertisement, but, as is usually the case, the most striking objects were of subordinate interest, and the really valuable objects needed careful and weary searching, and most frequently one failed to find any adequate description or competent attendant when these treasures were found. The writer first quoted excepts from his strictures the Electricity building, but to me this building was an excellent illustration of the defects alluded to. Everything which would arrest the attention of the ignorant was shown in profusion. There were masses of light of many and continually changing hues, including an illuminated column with a make-believe indicator to mystify the beholder; but the searcher for the more modern application of electricity, the apparatus for signalling electrically by means of a ray of light; the Tessla apparatus; the means of heating by electricity, etc., was unsuccessful or partially so. So far as the general public was concerned, there might as well have been no electric stoves as those placed at the end of one gallery. Outside of a favored few the visitors were able neither to see the interior working of the ovens nor to obtain any information concerning them. If there is one department in which the enormous advance since 1876 should be shown, it is that of electricity, and yet when it is considered that the Bell telephone was first brought out there and that the then latest English apparatus for exact measurement of the electrical current were exhibited in profusion, while totally lacking from the British section of the electrical display at Chicago, it is doubtful if, to say the least, any superiority can be claimed at Chicago in 1893 over Philadelphia in 1876 in this particular, so far as the instruction of the general public is concerned. For the public the most instructive object lesson of the possibilities of electricity as an agent for decoration, light, heat and power was given by the Columbian Commission itself in the brilliant illumination of the dome of the administration building, the basin, and the electric launches and intra-mural railway.

The collection of paintings, while numerous, contained in the aggregate fewer objects of rare value than many much smaller and less pretentious collections of modern days, both international and national.

The agricultural display was fine but was a disappointment to those who expected to see a full representation of the agricultural implements of all the nations of the earth which manufacture such objects. Here, as elsewhere throughout the fair, many objects whose place was in the building were sequestered by the commissioners to adorn State buildings or to meet the eyes of the more general public in the greatest building, *i.e.*, that of Manufactures and Liberal Arts.

There seems to be no difference of opinion as to the shoe and leather exhibit. With the exception of the Russians, and possibly one or two individual displays, the contents of the splendid building consecrated to this subject were disappointing or without significance.

As to the Mines and Mining, in hardly any part of this great profusion of objects was any attempt made to educate as well as to astonish the non-professional visitor.

Great piles of rocks and ores were scattered about, but utterly without system in most cases. The silver statue of Ada Rehan, the purely hypothetical miner's cabin built out of ores and the more or less artistic statue of a distinguished far western fellow citizen of the self-taught sculptor in sandstone, of which the advertisement took the place of a catalogue, were the cynosures.

As for the rest, either a few mines or localities were

more than amply represented, to the exclusion of many others equally important, or in some cases a great mining State was not represented at all. In all but one or two cases the labels, by means of which the public derives all its concrete information, were without other than local and superficial information; very often they were carefully concealed beneath the specimens they should have described, or illegible, or in a foreigh language unknown to the average visitor. In the German exhibit no account was made of the products and methods which for seven hundred years have made of Saxon Freiberg the Mecca of the miner and metallurgist. The superb collection of iron from Sweden, which was one of the chief attractions of the Centennial, was not represented by anything worthy to be mentioned in comparison, and though Germany exhibited a fine column of steel rails and the peerless Krupp products, these latter were housed in the Krupp building by themselves.

So far as this part of the fair was designed as a means of instructing the public, its value was much less than that of the corresponding department of the earlier exposition. While it is not claimed that there may not have been sections in which the display at the Columbian fair was superior to that of 1876 in other respects than in mere size, the writer firmly believes that the earlier fair was better as an educator and that its influence on American industrial progress will prove to have been more far-reaching and salutary than the stupendous spectacle just concluded.

OWL NOTES.

BY A. W. ANTHONY, SAN DIEGO, CALIFORNIA.

In a recent number of *Science* Mr. E. J. Hill gives an interesting account of capturing an owl under circumstances that might lead the reader to think that members of the owl family were dazed by sunlight. This may be the case with some owls, but I have, as yet, never fallen in with any so affected. There is no doubt that the bright glare of the sun is disagreeable to some species, but after flushing a short-eared owl and witnessing the ease with which it threads its way through tangled shrubbery, despite the sunlight, all doubts regarding their vision at such times will be set aside.

Very often, however, an owl will, in hopes of remaining unobserved, allow a person to pass remarkably near, often assuming an attitude suggestive of the knots on the limb on which it is perching.

Long-eared owls are often very averse to flying, judging from my observations. I have suddenly come upon one face to face, and sometimes several that were passing the day in a dense willow, and they immediately assumed a rigid, stick-like position, drawing themselves up to twice their natural length, evidently trusting to their resemblance to the surrounding stubs and branches, which was by no means slight. To escape notice—so great is their faith in the protection afforded them by this resemblance, when several are together, as is often the case in winter—one or more may be shot without the rest showing so much as by the movement of a feather that they are disturbed.

On one occasion a friend with whom I was hunting came upon five of these owls all in a row on a limb of a giant cottonwood. Beginning at one end of the line he shot them all, one after another, his last shot starting a sixth, which he had not seen, from a perch in the same tree. When I arrived upon the scene we began looking for the escaped owl, but failed to discover it. As we were leaving, however, my eye chanced to fall upon what, at first, appeared to be an abnormal growth on the trunk of a small sapling near us, but which, upon a second glance, proved to be a little screech-owl. With its back against the trunk of a tree it was drawn up to its fullest height, all its feathers drawn tight against its body, its ear tufts erect. It looked to be twice its normal length, and so closely did it resemble the gray bark and branches that, unprotected as it was by leaves or twigs and in the strong glare of a bright winter's day, its discovery was purely accidental. Our tracks in the snow proved that we had several times passed within ten feet of the bird, and it was quite evident that it was aware of our presence; for while it made not the slightest movement, it watched us constantly through its half-closed lids, trusting, no doubt, to escape detection, but ready to fly if the occasion required.

On another occasion, while collecting birds along the Platte River, I discovered a screech-owl in a very similar position. The morning was very cold, and *Megascops* had sought the sunny side of a small cottonwood, where, with its back against the trunk, it was enjoying the gratefnl warmth of the bright sun. When discovered it had assumed such an attenuated position that, although quite close, I was by no means sure that it was not a broken branch that had attracted my attention. Thinking to secure a specimen but slightly mutilated, I fired at it with dust shot, but was surprised to see not the slightest movement from the statue in gray before me. Could it be that I had been deceived after all and had fired at a knot? Half inclined to believe that such was the case, I went forward to investigate and when within fifteen feet could see that I was closely watched through narrow slits between the lids. Not a movement was made, however, until I was about to lay my hands on it, and then my owl quietly slipped around the tree and was gone. It is probable that my shot, being so fine, had not penetrated the feathers, as it was not injured in any way apparently.

I once caught a screech-owl on her nest, and while I was by no means gentle in bringing her out into the open air, she was, apparently, sound asleep, and no amount of handling would awaken her. I whistled in her ear, opened her wings and laid her down on a limb, all to no purpose. Megascops had evidently been out all night and did not propose to be disturbed by such trifles. While investigating the contents of the nest she was allowed to lie on a branch for some minutes but gave no sign of life, but I no sooner attempted to drop her to the ground than she revived. Before she had dropped a foot the wings opened, and away sailed my owl, as much awake as any bird and probably congratulating herself upon a piece of very clever acting.

—D. Van Nostrand Company, 23 Murray and 27 Warren streets, New York, design issuing the new edition of their complete catalogue of scientific books in sections, of which Parts 1 and 2 are now ready. The others are in preparation and will be issued in the order named, and copies will be sent gratis on application, as soon as issued. Part 1, Steam and Mechanical Engineering; Part 2, Electricity and Magnetism; Part 3, Chemical and Physical Science; Part 4, Civil Engineering; Part 5, Manufactures and Industrial Arts and Processes; Part 6, Geology, Mineralogy, Mining and Metallurgy; Part 7, Hydraulics and Water Supply; Part 8, Astronomy, Meteorology and Navigation; Part 9, Architecture, Building, Carpentry and Decoration; Part 10, Shipbuilding, Naval Architecture, Yacht and Boat Sailing and Building; 11, Drawing, Painting, and Photography; 12, Mathematics.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The Editor will be glad to publish any queries consonant with the character of the journal.

Native Calendar of Central America and Mexico.

In his recent work on this calendar, Dr. Brinton, referring to the mathematical basis on which it is founded, makes the following statement :

"An ingenious theory of the mathematical development of this calendar has been offered by Mrs. Zelia Nuttall. It assumes that at the close of each period of $20 \times 13 = 260$ days, 5 intercalary days were inserted before the next 260-day period was technically commenced. This naturally brought its commencement on the next subsequent Dominical day, and also caused the whole period, 265 days, to equal, very nearly, nine lunations. If it can be shown that the intercalation actually took place, Mrs. Nuttall's suggestion will have cleared up one of the most obscure problems in American archæology."

If I rightly understand the author, there appears to be in this a misconception of the relation of the 260-day period to the solar or ordinary year. If these periods followed one another with intervals of only five days, they could not possibly bear any fixed or determinate relation to the ordinary years. Now I have always supposed, and, from all the evidence I have been able to obtain upon the subject, still believe, that each ordinary year *included* one sacred period, or "vague solar year," as Dr. Brinton terms it. Mr. Cushing informs us that this is beyond question the idea entertained by the Zuñis in reference to their time systems, or, as he expresses it, the sacred period, embracing some eight or nine months of each year, "is the kernel of the ordinary year," being governed, however, as to its commencement and ending by the phases of the moon.

It will also be observed that the same idea appears to be indicated by the time series of the Mexican Codices (as, for example, that on plates 31–38 Borgian Codex). These, we see, are bordered above and below by a line of symbolic figures which we may justly assume—as there are 52 in each line (104 in all)—represent the remaining days of the year—lacking one. As they exactly fill the divisions of the space, we may suppose this was the reason one was omitted, or there may be some other explanation. In other words, I believe the scheme of the plates indicates that the sacred period was *included* in the secular year; or, to reverse it, that each ordinary year included one sacred period of 260 days. If Mrs. Nuttall had said "105 days were added," there would be complete agreement. This sacred period, being, in all probability, regulated to some extent by the moon, would shift somewhat its time of beginning and ending.

I may add here (but expect to present the reasons therefor more fully in a future paper) that there are substantial reasons for believing that we must look beyond the boundaries of our continent for the origin of this calendar. The flower, when we first find it here, is too fully blown to suppose it thus came into existence; there must have been a bud and germ somewhere. These have not as yet been found in other American tribes.

I think we may assume that the natural basis was the revolution and phases of the moon; the mathematical basis the count of the fingers and toes, beginning with five; and that the mystical reference to the cardinal points also entered into its formation. As indicating the line of research most likely to lead to satisfactory results, I refer to the following facts :

According to Mr. Cushing, a particular color was assigned by the Zuñis (as by many other peoples) to the cardinal points, but to the focus or centre a *mixture* of colors, or, in other words, it was said to be "speckled." It is a singular fact that in the old "native" Javanese calendar the week cousisted of five days, each having a particular name. These were supposed to have a mystical relation to certain colors and to the cardinal points. "According to this whimsical interpretation," remarks Crawfurd ("Indian Archipelago"), "the first means white, and the east ; the second red, and the south ; the third yellow, and the west; the fourth black, and the north; and the fifth *mixed color*, and the *focus* or centre." Let us suppose this, as it is so far away, to be accidental.

According to Judge Fornander ("Polynesian Race"), the Hawaiians formerly counted twelve months, of thirty days each, to the year, and added five days at the end of the last month—*Welehu*—to make up the 365, these being "tabu-days." Each month and each of the thirty days of the month had a particular name. He also adds that they had two modes of reckoning time, one by lunar cycles, whereby the monthly feasts were regulated; and the other the sidereal year, which appears to have been regulated by the rising of the Pleiades. He also adds the further important information that the feasts, or Kapu-days, were observed *only during eight months* of the year. This period corresponds somewhat closely with the sacred period of the Central American and Mexican calendar, and also with the sacred period of the Zuñis.

Mr. Dibble, in his "History of the Sandwich Islands" (Edn. 1843), gives some additional particulars, which, though somewhat confused from want of a thorough knowledge of the system, have a strong bearing on the question of the origin of the Mexican calendar. He says the Hawaiians divide the year into two seasons of six months each; that the year consisted of twelve months. He adds further that "In one year there were *nine times forty nights*." Here we find the nine-day series introduced corresponding with the puzzling nine "Lords of the Night" of the Mexican calendar. This coincidence is remarkable. As the change from nine to eighteen and from forty to twenty was simple, we may find herein an explanation of the eighteen months and twenty days of the calendar. "These nights," says Mr. Dibble, "were counted by the moon. There were thirty nights in each month, *seventeen of which were not very light and thirteen were.*" These numbers are very significant in this connection. Yet it is apparent that the author, not understanding the system, gives but fragments. In his attempt further on to explain the revolution of the count by the moon and the sidereal year, this confusion becomes more evident and is partially, though not fully, corrected by Judge Fornander. But enough is given to show that the two periods, the sacred and the secular, were in use, and that the system was very similar in its unusual features to that in use among the Mexicans and Central Americans.

Cyrus Thomas.

Washington, D. C.

Raining Worms and Frogs.

While reading the letter of a correspondent in the issue of January 7, on "Does It Rain Worms?" I was reminded of Thomas Cooper's statement in his autobiography that he *saw* it rain frogs when he was a boy.

A waterspout on the Yellow River in China will sometimes pour down till it makes the river seem to boil in fury, and then all is reversed, the water in immense quantity is drawn up with the fish, sticks, straws—and even the loose stones from the river bed—and carried along the sky until the wind drops, and then the fish, frogs, etc., fall down, and people are astonished at the marvel. Probably the frogs seen by Mr. Cooper may be accounted for in this way. Francis Huberty James.

Boston, January 18, 1894.

Frost Plants.

PROFESSOR MCDOUGAL'S article in *Science* for Dec. 29, 1893, and especially Professor Atkinson's notes in the *Botanical Gazette* for January, 1894 (p. 40), prompt me to record another fact tending likewise to show how hard it is to make an absolutely new observation in science, and how slightly what are afterwards found to be interesting facts of science are apt to impress us when first discovered. I was driving one day last summer through the section where Mr. Mason and I had seen the frost flowers of *Cunila* in company with Mr. William Hunter, now of the National Zoölogical Park, but who was reared in that country, and has recently become thoroughly acquainted with its flora, furnishing me from there a large number of additions to my flora of Washington and vicinity. As we passed the spot I pointed it out to him and told him there was where we saw the frost-freaks. With perfect naïveté he replied that he had been familiar with them all his life, having played with them when a school-boy at the village of Accotink, hard by! LESTER F. WARD.

Coral Reef Formation.

I HAVE just seen Dr. Le Conte's note concerning "Coral Reef Formation" in *Science* for Dec. 8, p. 318.

I am sure that all who are interested in the study of coral formations will be grateful to Dr. Le Conte for calling attention to his paper, which is of much importance. In my search for whatever had been written on the subject I intended to be thorough, but I wholly overlooked the paper referred to. I greatly regret that this is so, for not only does the oversight leave my account incomplete, but does, although quite unintentionally, injustice to one whom all scientists delight to honor, and I am very glad that Dr. Le Conte did not allow the matter to pass unnoticed. I hope that any who may read my paper in *Science* for October 20 will also add the note in *Science* for December 8. GEORGE H. PERKINS.

University of Vermont, Dec. 27, 1893.

Earthquakes in the San Juan Mountains.

ABOUT midnight the morning of Jan 1 an earthquake shock was felt at Silverton, Red Mountain, Ouray, and other points in the San Juan Mountains. Another came at half-past one, another at three, another at four, and again at half-past seven. No clocks were stopped, and the times are only known approximately. Windows and dishes rattled, walls and roofs creaked, a sound as of a team rushing over the snow was heard, in one miner's cabin on the mountain a stove was overturned, and in small houses the floors distinctly trembled and reeled. Most of the shocks were accompanied by a single loud sound, as of a heavy blast—a familiar sound in these mountains. These noises were very distinct in the mines at Red Mountain up to 600 feet in depth. Similar shocks came at intervals for two days and three nights after the first. The wide extent of country over which the phenomena were substantially the same makes it probable that these shocks proceeded from some point at a distance. No one seems to have been able to perceive the direction of propagation. Did they proceed from some distant volcanic eruption? GEO. H. STONE.

Ouray, Colo., Jan. 6, 1894.

An Explanation of the Rope of Maggots.

THE "Rope of Maggots" which Mr. Jones described in *Science* of December 29 was due to the larvæ of a fly belonging to the genus *Sciara*, of the family *Mycetophilidae*, a genus which includes many species. The phenomenon, while it has been but seldom observed in America, has been long known in Europe, especially in connection with the larvæ of *Sciara militaris*, which derives its specific name from this peculiar habit. The maggots are known as the "Heerwuerme" or, in English, the "army worms." We have several species in America which are closely allied to *S. militaris*, and it is perhaps the larvæ of some one of these species which formed the "rope" in the case mentioned. I have never seen any reason given why the larvæ congregate and travel in this way. They do not feed on carrion. S. W. WILLISTON.

Petrified Eyes.

Is it known that the crystalline lens of the eye has ever been petrified in homogeneous quartz? I have never seen or heard of such a thing except in a popular school geology, and do not believe the following statement, which is taken from the book:

"A monster, some thirty feet long, with jaws nearly a fathom long, and huge saucer eyes, which have since been found *so perfect that the petrified lenses have been split off and used as magnifiers.*"

Have such lenses ever been found, or is this merely the material of which elementary science books are formed?

GEO. G. GROFF.

Lewisburg, Pa.

"Do Earth Worms Rain Down?"

IN *Science* of Jan. 5, under the above caption, Charles B. Palmer refers to the old-time notion that worms, frogs, fish, etc., rain down as one seldom mentioned by intelligent people except in the way of ridicule. That this notion is yet entertained by many will appear from what follows. A few days ago I presented this subject to a class pursuing the study of zoölogy, and several stated they had found fish and frogs after a rain on land where before no water could be found. A young man, of undisputed intelligence, declared that about two years ago, in this city, children on their way to school picked up fish as they fell on the sidewalk in a rain storm and brought them to the school where he was in attendance.

On Jan. 20 a wind unusually heavy for this section prevailed in Nashville. Rain fell abundantly in the latter part of the day. In the evening seven young men were standing under the awning of a certain store when they heard a sudden splash, mud and water being thrown on one of the boys and upon the corner post of the awning. Their attention was directed to a living creature about five feet from the pavement, which they succeeded in capturing. The specimen was brought to me for indentification and proved to be a full grown sword-shaped salamander (*Amblystoma xiphias*), measuring ten and three-fourths inches in length. Upon questioning the young men I obtained the following testimony: They did not see it falling; they did not see it in the air; they heard the splash; in falling it buried itself in the mud and water; they were fully persuaded that it had rained down.

The following day I observed earthworms on the brick pavement. This fact and the occurrence of the above species in mid-winter away from winter quarters, together with the facts that butterflies, moths and grasshoppers were seen on the wing on Christmas Day, that a butterfly (*Agraulis vanillae*) emerged on Jan. 15 in a breeding cage which had been kept in a cool room, that the phœbe has been spending the winter with us, and that such flowers as the ground ivy and dandelion have been in bloom, will suggest the mildness of the winter we have experienced up to the middle of January. WM. OSBURN.

Nashville, Tenn., Feb. 1, 1894.

The Mystery of Worms in Rain.

THE mysterious appearance of earth worms at certain times and places mentioned by Mr. Charles B. Palmer in *Science*, No. 570, is easily explained, it seems to me, by close observation of the worms under favorable conditions. Several of his queries are answered more or less directly by the following quotation from the manuscript of a little book on animal studies which I prepared saveral years ago, but which was never published:

"The time was in May during very rainy weather. The best place for observation was a portion of the lawn over which earth had recently been spread several inches deep. The bare ground of a garden which had not been disturbed since last year was almost as good.

"On going out in the early evening, a constant slight snapping sound could be heard proceeding from the ground. Moving carefully, in order not to jar the ground and frighten the worms, a spot was selected for observation.

"Looking closely, a dozen or more worms could be seen on each square foot of ground; some extended nearly full length on the surface, others protruding but an inch or so of the head. All were constantly moving the head about as if searching for something. Next morning several holes were found with blades of grass drawn partly in.

"A two-gallon jar was nearly filled with moist earth and placed in the house, where a lamp could be used for observation at night. Some worms were put in and a few blades of grass placed on the earth. All the worms kept below the surface during the day, but in the evening were always active at the surface.

"One evening after a rain a worm was noticed crawling on the second step of the porch. A few minutes later it was crawling along the *under* side of the projection of the third step and was soon over on the top investigating things to its satisfaction."

Under ordinary conditions the worms remain concealed in their burrows during the day, but they habitually come to the surface at night, as is well known. That they immediately seek to penetrate the earth on being dug up necessarily follows from their extreme wariness, which prompts them to retreat at the least sign of danger. When they come to the surface "to be pelted by the rain" I have no doubt that they are accepting the lesser of two evils by escaping a deluge underground. Having seen a worm crawl comfortably along the under side of a painted board, I see no reason why it should not reach the roof and go down the conductor to the cistern. Nor does its climbing powers seem remarkable when we consider the moist, clinging body, and the peculiar organs of locomotion.

This does not disprove the "rain down" theory, but only shows that, so far as earth worms are concerned, the phenomenon may have a more reasonable explanation. As to the sudden appearance of frogs after a shower, it is stated that this is a common occurrence in certain tropical countries, where the excessive heat and dryness drive them to seek shelter under leaves and earth till the cooling rain calls them out. In the month of August I have found live water beetles of the family *Hydrophyllidæ* buried deeply in swamp earth, where they had retreated probably two months before when the last drop of water evaporated. The remarkable degree of adjustment to the evironment, which permits most animals of the lower orders to remain for a long time in a state of suspended activity, will doubtless explain most of these mysterious apparitions when all the conditions are known.

C. D. MCLOUTH.

Muskegon, Mich., Jan. 20, 1894.

BOOK REVIEWS.

An Elementary Treatise on Theoretical Mechanics. By ALEX. ZIWET. New York and London, Macmillan and Co. 1893, two vols.; 8vo, pp. 181,175.

THE two volumes here mentioned contain, the one the outlines of kinematics, the other those of statics. A third volume, to include the treatment of dynamics, is promised later. The author, Professor Ziwet, of the University of Michigan, has sought to secure a good text-book in pure mechanics, especially well adapted to the student in the higher class of American colleges. The European method of study of the mathematics is stated to be the presentation of the science of mechanics before taking up the higher mathematics and its review after a later study of the calculus and other advanced mathematical studies. In this country it is more usual to study mechanics only after the course of higher mathematics has been taken. The work is intended as an introduction to the science of theoretical mechanics; but is also expected to prove useful to engineering students preparing for work in applied mechanics and related subjects. Theories are illustrated by special problems, and sets of exercises are introduced to be worked out by the student. Good care has been taken to make the references full and amply numerous to facilitate later or collateral reading.

The treatise on kinematics is one of the best which has been yet presented and gives an excellent presentation of this comparatively recent, and, as yet, incompletely developed, science. It is based on Reuleaux and other German writers mainly, and is one of the most systematic and continuous discussions of the subject which has appeared in English. The subject of statics is well planned, well written and well carried out in detail. The whole work is evidentally the product of one familiar with his subject and capable of giving his work the form which experience has shown him to be desirable. The book-making is excellent. The paper and press-work are admirable, and the two volumes are most creditable to both author and publisher.

A System of Easy Lettering. By J. H. CROMWELL. New York, Spon and Chamberlain, 1893, 27 p., 12mo, $0.50.

THIS little book is full of excellent illustrations of the most simple, as well as the most complicated and most graceful, forms of draughtsman's letters, arranged and proportioned especially for his use. The scheme is simply as stated in the preface: "We have but to divide any surface we may wish to letter into squares (or parallelograms, as the case may be) in pencil lines; form the required letters, in ink or paint, and, according to the style chosen, erase the pencil lines, and the lettering is complete." The selections are good, the work is excellent and the make-up of the book all that could be desired.

Steam Machinery and the Marine Engine. By J. LANGMAID and H. GAISFORD, of the Royal Navy. London and New York, Macmillan & Co. 1893, 8vo, xv., 267 p. New edition, revised and enlarged.

THESE elementary lessons in steam marine machinery are prepared for the use of the naval cadets of the British navy, and are introductory to more formal and mathematical studies. They include a purely descriptive account of the details of machinery, prefaced by chapters on the forms and uses of drawing instruments, statements of the properties of the materials of engineering construction, and of the various forms of joints and fastenings, such as riveting and bolting. The book is very exceptionally well-illustrated, and all the important engravings are made to a stated scale, so that it is easy to ascertain

the dimensions, as well as the proportions, of the parts represented. The different shapes adopted for shafts of marine engines and their accessories, cranks and rods, eccentrics and cams; toothed gearing of all usual kinds; stuffing boxes and joints; valves and cocks and pumps, and other minor parts, are all well-described and finely illustrated before the construction of engines and boilers is studied in larger plans.

Drawings and descriptive text exhibit the forms and proportions of the modern marine boiler and of all its appurtenances; while in this connection, the fuels and their composition, the properties of steam, and the economics of steam-making, are presented in a simple manner. Similar methods are adopted in the treatment of the marine engine, and the most recent types are fully described.

No attempt is made to give the mathematical principles involved in construction, or to teach the art of designing and proportioning the engine, the boiler, and their accessories. The book has little value to the engineer; but, as an introduction to the serious study of the steam-engine for marine purposes, it is admirable. The authors and publishers have done their work well, and we have rarely seen a finer piece of technical book-making. Paper, press-work, and binding are good, and its illustrations among the very best that we have ever seen in this department of literature.

NOTES AND NEWS.

Mr. Henry C. Mercer, the newly appointed Curator of American and Prehistoric Archæology at the Museum of the University, delivered an address on "The Human and Animal Remains in the Lookout and Nickajack Caves at Chattanooga, Tenn.," before the Numismatic and Antiquarian Society of Philadelphia, on the evening of Jan. 4. Mr. Mercer referred to the importance of cave explorations in European archæology, and stated that the one fact that we gather is that early man dwelt in caves. Little cave hunting has been done in this country, chiefly because American archæologists have gone wild over "relics," and mounds and cliff dwellings had diverted attention from other explorations. The speaker reviewed the work done in examining caves in this country, such as the investigations made by Professor Rogers at Durham Cave and Haldeman at Chikies, as well as the Port Kennedy "bone hole" explored by Professor Cope. A great scantiness of animal remains as compared with similar caves in Europe characterizes American caves, and this is accounted for by the difference in the conditions. The Lookout Cave at Chattanooga he regarded as typical. The floor of the cave, like that of many of the other caves in its vicinity, had been disturbed during the War of the Rebellion by workmen engaged in digging nitrous earth for the manufacture of gunpowder. He talked with the men who had been engaged in this work, and learned from them the portion of the floor which they had not disturbed. The bottom of the cave contained a mass of human and animal refuse. The floor was divided into sections by the explorer, and each fragment of bone, pottery, or stone was marked with the number of the section, and a number indicating the depth; so that things found in the first foot of digging were marked "one"; in the second, "two," etc. This work was carried down a depth of about four feet to the bottom of the animal deposits, and the contents appeared entirely homogeneous. The remains were Indian throughout, and decorated pottery was found in the lowest part. No indication of palæolithic man, nor of pygmies, nor of any one except the familiar Indian was discovered. The bones and shells have been identified by Prof. E. D. Cope, and reveal the following fauna: Deer, opossum, lynx, squirrel, rabbit, bat, peccary, raccoon, marmot, water tortoise, soft-shelled tortoise, sucker, garfish, spadefoot

toad, tapir. Of shells, two species of Io, seven of Unio, two of Paludina and Trypanostoma were found. Most important of all, in the opinion of the explorer, were remains of the peccary and tapir. Teeth of the latter, the speaker stated, were found so near the bottom of the deposit that they may have belonged to the lower alluvial strata, and not to the period of the human remains. In the discussion on the paper President Brinton stated that the tapir was commonly regarded as a South American animal, but that within our century it had been observed as far north as the Isthmus of Teotehuntepec, and that it was not necessary to take refuge in the theory that the teeth of the tapir belonged to the lowest strata, as it is not unlikely that the tapir existed in the Gulf States within a comparatively recent time. Mr. Mercer gave an account of an Indian ossuary that he found in a rift in the Lookout Cave, and exhibited specimens of charred femurs and the fragment of a pierced gorget, with stone arrow points from this deposit. In conclusion, he urged the importance of a thorough exploration of the caves of the entire country as likely to settle the question of early man in America. Dr. Brinton did not think the absence of objects of a primitive type in caves as conclusive with reference to the absence of primitive man. Early man was probably arboreal, and did not live in caves at all. According to the best French archæologists, the man of the river drift was older than the cave man, and his bones are associated with remains of a fauna that required a tropical climate for their development. The fossil remains from the explorations were exhibited at the close of the meeting.

—It is with deepest regret that we announce the destruction by fire of the new Engineering Laboratory at Purdue University, LaFayette, Ind. It was burned on the night of Jan. 23—four days after its dedication. The fire originated in the boiler room and spread with great rapidity. Its progress could not be checked until the larger part of a fine building had been destroyed. Three laboratory rooms were burned; the machine room with its twenty lathes, its planers, shapers, drill presses, milling machines, and its large supply of small tools; the forge room with its thirty-two power forges; and the laboratory for advanced work, which contains Purdue's now famous locomotive "Schenectady," a triple expansion Corliss engine and much other apparatus designed for work in steam engineering, hydraulics, and strength of materials. Nothing in these rooms escaped the fire. Not only was all the apparatus lost but also a large amount of experimental data. The main portion of the building was also consumed. This contained three stories, 50 feet by 150 feet. It was occupied by drawing rooms, recitation and lecture rooms, instrument rooms, offices and a mechanical museum. Some of the furniture and apparatus in these rooms was carried out before the fire took possession, but, as already stated, this part of the building was entirely burned. The only portion still standing comprises the wood room and foundry. These rooms were not damaged except by the temporary removal of the more portable portion of their equipment. The incidental losses by the fire are considerable. Members of the faculty have lost books, papers and data; students, their instruments, and manufacturers, in every part of the country, who, by gifts or liberal discounts, had coöperated in the equipment of the building, have lost their representation there. The excellent facilities for laboratory training which Purdue has been able to offer have made her engineering departments well known and have helped to draw to them a large number of students. It is hoped and expected that the new building will be quite as extensive and its equipment quite as complete as were the building and equipment which have been lost, and, since experience has suggested the modification of many details, it is but reasonable to expect the second plant to be better than the first.

EXCHANGES.

[Free of charge to all, if of satisfactory character. Address, N. D. C. Hodges, 874 Broadway, New York.]

LIVING near the famous "Serpent Mound," Adams County, Ohio. I have had opportunity to make a collection of pre-historic relics. I will sell same to any one interested in archæology. Write me. Warren Cowen, Elmville, Highland County, Ohio.

TO EXCHANGE.—Herbarium specimens. Address, H. P. Chandler, Beaver Dam, Wisc.

KARYOKINETIC FIGURES IN MAMMALIAN TISSUES.—Since the publication of my Preliminary Notice in *Science* for Dec. 1, 1893, many parties have written me asking for permanent preparations showing mitosis. To these parties I have sent slides, and I now offer to all who desire them slides showing mitotic figures in nuclei of embryo kitten. A good immersion objective is necessary to make out the figures satisfactorily. Send 60 cents in stamps. If the slide is not satisfactory, return it, and I will return the money. I do not care to exchange slides. Frank S. Aby, State University, Iowa City, Iowa.

FOR SALE.—A small collection of bird skins, consisting of 135 specimens of New England species, most of which are in good condition and all have full data. Nearly all were collected in the Connecticut valley in Massachusetts. Price, $10. Address, H. L. Clark, 3922 Fifth Avenue, Pittsburgh, Penna.

FOR SALE.—Price $150, cost originally between $300 and $400, a microscope and following accessories: Acme (No. 2), stand and case lost, $75; Crouch, one-fifth collar adjustment and objective, $25; Tolles, four-tenths ditto, $45; Tolles amplifier, $12; Bausch and Lamb, half solid eye piece, $8; Bausch and Lamb, acromatic condenser, $18; Hartnock Polariser, $30; turn-table, $6; Hartnock, camera lucida, $20. D. T. Marshall, Metuchen, N. J.

TO EXCHANGE.—Works on entomology, botany and palæontology for works on Indiana and archæology. H. Justin Roddy, Millersville, Pa.

FOR SALE.—A Zertmayer new model U. S. Army Hospital monocular stand, cost $110. H. C. Wells, 151 Broadway, New York.

WANTS.

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WANTED.—Second-hand books on osteology, embryology, and comparative anatomy. Send list, stating condition and cash price. Can offer a few good sets of birds' eggs if desired. R. C. McGregor, Palo Alto, California.

WANTED.—A copy of Chapman's Flora of the Southern United States. I have on hand for sale or exchange sets of the lichens of this vicinity. List furnished on application. Address, C. F. Maxwell, Box 127, Dublin, Tex.

WANTED.—Addresses of persons interested in archæology. Copies of the new archæologic journal in exchange for lists of collectors. A collection of 10,000 valuable objects, the results of my nine years' exploration in the Mississippi Valley, for sale. Price, $7,650. Warren K. Moorehead, Waterloo, Indiana.

WANTED.—Vol. Birds of the Standard or Riverside Nat. Hist. Preferred in parts. F. A. Lucas, U. S. National Museum, Washington, D. C.